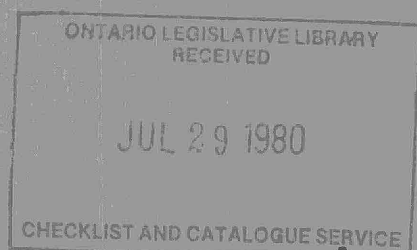
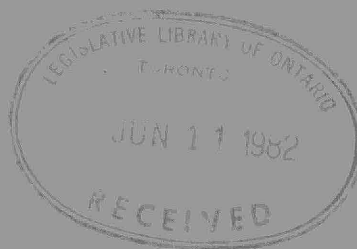


MERCURY LEVELS IN FISH FROM NORTHWESTERN ONTARIO, 1970-1975



April, 1976



Ontario

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The Honourable
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Minister

Everett Biggs,
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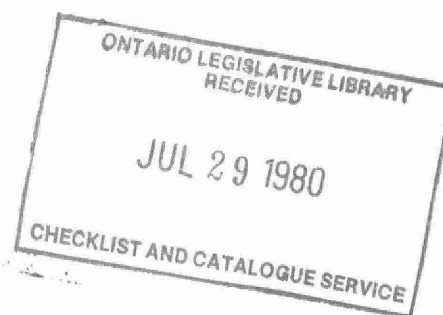
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NORTHWESTERN ONTARIO, 1970 - 1975



J. N. Bishop
B. P. Neary

Inorganic Trace Contaminants Section
Laboratory Services Branch
Ministry of the Environment

April, 1976

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INTRODUCTION

Mercury contamination of certain fish populations in Canada has been documented since 1969 (1). Various water systems have been shown to contain fish with mercury concentrations in excess of the currently accepted federal health guideline of 0.5 mg/kg (ppm) (2). Of these water systems, the basin of the Wabigoon-English River contains fish with some of the highest mercury concentrations reported in North America.

A chlor - alkali plant began operation in March 1962 at the town of Dryden, on the Wabigoon River. An estimated 20,000 lb of mercury was discharged in the plant's wastewaters between 1962 and 1970 (29). In March 1970, a control order was issued by the Ontario Water Resources Commission instructing the Dryden plant to reduce mercury containing water-borne wastes. The company complied by installing various treatment systems up until October 1975, when the company switched over to a permionic membrane system and dismantled the mercury cells.

Major surveys of fish have been carried out in this part of Northwestern Ontario since 1970 by the Ontario Ministry of Natural Resources (MNR), the Ontario Ministry of the Environment (MOE), the Freshwater Institute (FI), and by other investigators. Analyses of the fish gathered in these surveys were performed by the Fisheries and Marine Service Inspection Branch (FMSIB), the MOE, and by private laboratories. This report summarizes all available information on mercury levels in fish from these sources.

A. BACKGROUND INFORMATION:

I: GEOGRAPHICAL

The area under examination is located in the northwestern portion

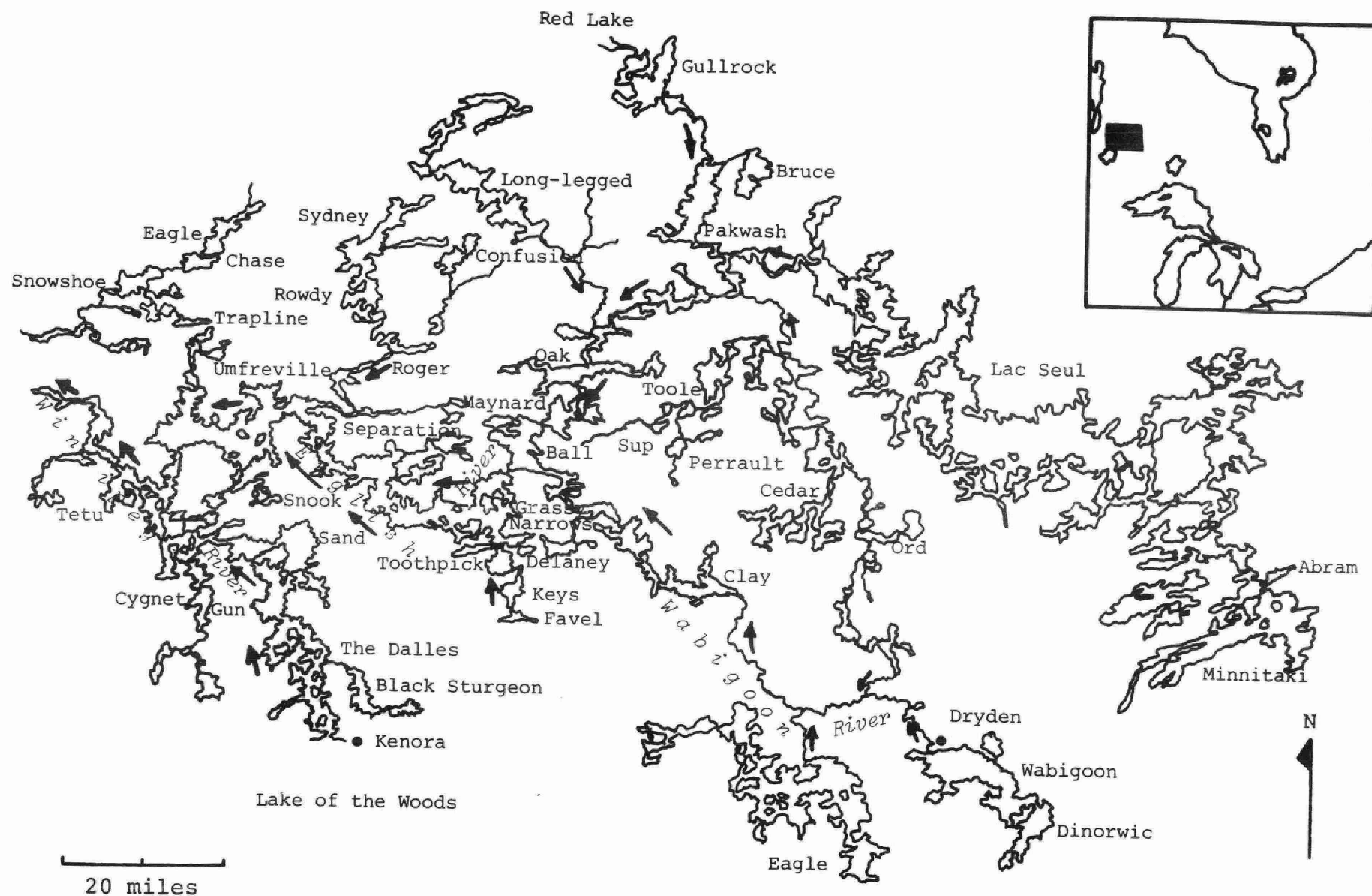


FIGURE 1: WABIGOON-ENGLISH-WINNIPEG RIVER SYSTEMS

of Ontario (see Figure 1) and is within the region bounded by 91° 30' W to 95° 00' W and 49° 00' N to 51° 00' N. The major river system in this area, the Wabigoon-English-Winnipeg, and its watershed comprise the most intensively sampled water bodies. Off-system lakes were also sampled in an attempt to establish background mercury levels for the area.

II: GEOLOGICAL

The physiographic characteristics of the land drained by the Wabigoon, English and Winnipeg rivers are described in detail by Zoltai (3). The Wabigoon River drains a basin consisting of moderately to weakly broken areas of deep to shallow lacustrine clay in knolls and flats with shallow sandy till ridges over bedrock. Lakes cover a moderately large portion of the area, and have clayey or bouldery lakeshores. Active erosion of clay banks produces periodic muddy conditions in the larger lakes, such as Clay, Dinorwic, and Wabigoon.

The landscape forming the English River basin is similar, except that the clay zones are less prevalent, and bare bedrock ridges are frequent in some parts of the area. The Winnipeg River basin consists of a moderately to weakly broken area of shallow sandy till over bedrock, with frequent bare bedrock ridges. Lacustrine clay occurs in many flats or valleys.

The bedrock is primarily granitic interspersed with individual "greenstone" belts. Mineralization is commonly associated with these belts, and most base metal mining operations in this part of the Canadian shield are located in "greenstone" belts (4). Examples of such mines can be found at Red Lake

(gold with reserves of zinc and copper), Confederation Lake (zinc) and Atikokan (iron and copper). Mercury levels in lake sediments near these sites are approximately twice as high as the average background level in other parts of the shield. For example, the mercury content of the sediment cores from Red Lake range from 33-63 ug/kg, Confederation Lake 38-47 ug/kg, while those from the northern permafrosted shield average 20 ug/kg (4).

III: SOURCES OF MERCURY

It is very difficult to precisely delineate the relative proportions of mercury due to natural mineralization and that caused by industrial activities. A careful examination of the mercury concentrations in fish on and off the system, however, can yield reasonable estimates of the relative effects of these contributions.

The following are possible causes for elevated mercury levels in fish:

- natural mercury deposits,
- aerial fallout of mercury due to smelting or burning of fossil fuels,
- mining activities, including indigenous mercury in tailings and mercury used in amalgamation of gold or silver,
- the use of mercury in the production of chlorine and caustic soda.

As mentioned in the section describing the geology of the area, some lakes may have significant natural mercury inputs, as well as mercury contributed by mining activities.

IV: MERCURY PATHWAYS TO FISH

All of the possible mercury inputs to the system consist primarily of inorganic mercury. However, the mercury in fish muscle is virtually all in the form of methyl mercury (21). The production of methyl mercury is accomplished by micro-organisms living in sediments (22, 23) and once methylated, mercury is rapidly absorbed by fish via food or water, and incorporated into the fish muscle. Since methyl mercury is so readily absorbed, and since its biological half-life in some fish is over 700 days (24), conditions favouring the methylation of mercury can rapidly produce fish populations with mercury concentrations in excess of 0.5 ppm.

Recently, Bisogni and Lawrence (25) have produced a kinetic model for the methylation of mercury in aquatic environments that can be written

$$\text{NSMR} = \gamma (\beta \text{ Hg}_{\text{Total}})^n$$

where NSMR is the net specific methylation rate, γ is a coefficient determined by microbial growth rate of the system, β is the ratio of free mercuric ions to total inorganic mercury and is affected by the concentration of organic or inorganic complexing agents, and n is the pseudo-order of the reaction, which under laboratory conditions was 0.15 for anaerobic conditions, and 0.28 for aerobic systems. At neutral pH, the predominant product of methylation was monomethyl mercury. It has been reported (26) that at higher pH, dimethyl mercury is the primary product of methylation.

Each of the factors affecting methylation can be qualitatively discussed separately in the light of available data on the area. The coefficient γ relating to microbial growth is likely quite high, due to high inputs of organic matter from the Reed Paper plant in Dryden. In 1968, the average daily loadings to the Wabigoon River were 71,000 lb suspended solids, and 33,000 lb BOD₅ (27). Extensive deposits of wood fibres occur for at least 28 miles downstream of the plant (28), and these form an excellent medium for the growth of heterotrophic bacteria. The dissolved oxygen in the Wabigoon River is depressed from Dryden to the Eagle River, so the conditions are largely anaerobic.

The term (β Hg_{Total}) is difficult to assess. On one hand, the concentration of organic complexing agents is likely to be quite high, due to the high organic loadings to the river. This is substantiated by the correlations observed between organic matter and mercury concentrations in Clay Lake sediments (29). This would suggest that a large proportion of the mercury in the sediment is complexed, but since the mercury concentrations in the Wabigoon River sediments have been measured in excess of 10 mg/kg dry weight for some parts of the river, the available mercury source for methylation is nonetheless substantial. It has also been demonstrated that the ability of a sediment to produce methyl mercury is strongly correlated to its organic content (30) so that the high organic loading to the river would produce good conditions for the methylation of any available mercury.

Up to October, 1975, the Wabigoon River received a mercury input from the Dryden Chemicals chlor-alkali plant, and a high organic input from the Reed Paper plant, both in Dryden. In

combination, these provide an environment conducive to the methylation of mercury, and the subsequent contamination of the fish populations.

B. EXPERIMENTAL

I: SAMPLING

This survey is concerned mainly with the most current information on mercury in fish, that is, surveys carried out in 1975. Information from previous years' surveys is also presented. Table I lists the available fish surveys from which data was used in preparing this report.

TABLE 1
FISH DATA SOURCES

Date	Collected by	Analyzed by	Lakes	Number of Samples	Reference
1975	MNR	MOE	Ball	279	5
			Indian	1	5
			Tide	1	5
			Grassy Narrows	278	5
			Separation	212	5
			Umfreville West	163	5
			Tetu	134	5
			Sand	193	5
			Gun	329	5
			The Dalles	189	5
			Keys	83	5
			Delaney	201	5
			Blueberry	198	5
			Snook	136	5
			Gooseneck	241	5
			Toothpick	173	5
			Umfreville East	62	5
1975	MNR	FMSIB	Oak	148	6
			Maynard	109	6
			Toole	87	6
			Clay	42	6
			Sup	104	6
			Marshalluk	49	6
			Buck	20	6
			Chase	231	6
			Eden	118	6
			Meandering	113	6
			Routine	116	6
			Roughrock	176	6
			Snowshoe	197	6
			Trapline	142	6
			Eagle	214	6
			Favel	90	6
			Sand	47	11
1975	Whitedog Reserve	U. of Rochester	Caribou Falls (S.W. end of Umfreville W)	5	7
			Pistol	10	7
1974	MNR	FMSIB	Clay	77	8
			Ball	118	9
			The Dalles	113	9
			Grassy Narrows	133	9
			Gun	68	11
			Sand	130	11
			Separation	135	9
			Tetu	145	11
			Umfreville E	125	9
			Umfreville W	58	9
			Bruce	107	11
			Confusion	128	11

Date	Collected by	Analyzed by	Lakes	Number of Samples	Reference
1973	MNR	FMSIB	Blueberry	40	8
			Delaney	87	8
			Gooseneck	39	8
			Keys	62	8
			Snook	46	8
			Toothpick	55	8
			Tetu	153	11
			Portal	66	11
			Colonna	54	11
			Cygnat	58	11
			Oak	2	11
			Sand	106	11
1972	MNR	FMSIB	The Dalles	77	9
			Maynard	6	8
			Sand	93	9
			Confusion	95	11
			Umfreville E	*186	9
			Dinorwic	24	11
			Roger	155	11
			Rowan	286	11
			Snowshoe	187	11
			The Dalles	150	11
			Long-legged	199	11
1972	FRB	FMSIB	Clay	89	12
			Sydney	18	12
			Grassy Narrows	39	12
			Ball	40	12
			Separation	40	12
			Tetu	20	12
1972	B. Lamm	MSU	Wabigoon R. (E) (just after leaving Clay Lake)	79	14
			Wabigoon R. (W) (just before entering Ball L.)	98	14
			Ball	99	14
			Indian	62	14
			Scotty	35	14
1971	MNR	FMSIB	Ball	73	9
			English	18	8
			Maynard	237	9
			Oak	217	11
			Wabigoon	222	8
			Dinorwic	189	11
			Confusion	27	11
			Long-legged	9	11
			Rowdy	210	11
			Sydney	187	11

* Includes data from Umfreville W. for 1972

Date	Collected by	Analyzed by	Lakes	Number of Samples	Reference
1970	MNR	FMSIB	Ball Clay	5 68	8 8
1970	MNR	OWRC	Clay Gun	274 115	10 10
1970	MNR	FMSIB	The Dalles Grassy Narrows Gun Indian Lount Maynard Sand Separation Tetu Umfreville E. Wabigoon Umfreville W.	41 44 23 22 7 10 11 43 30 13 36 38	9 9 9 8 8 8 9 9 9 8 8 9
1970	FMSIB	FI	Clay Umfreville E.*	15 6	2 2
1970	Acres Cons.	ORF	Wabigoon Clay Ball Tide Wabigoon Indian Grassy Narrows Tetu Long-legged Oak Maynard Rowdy Sydney Roger Scotty	11 14 25 14 10 5 3 4 5 11 10 8 14 14 6	13 13 13 13 13 13 13 13 13 13 13 13 13 13 13

* Includes data from Umfreville W. as well

II: ANALYSIS

The fish were analyzed by flameless atomic absorption spectrophotometry. The FAAS methods used by the different laboratories are all variations of a method developed in 1968 by Hatch and Ott (15). The following table lists the laboratories in this survey along with the method used and its reference.

TABLE 2

METHODS OF ANALYSIS

Laboratory	Acronym	Method	Reference
Ministry of the Environment	MOE	H ₂ SO ₄ -HNO ₃ digest, Hot Block, KMnO ₄ oxidation FAAS using LDC Mercury Meter.	16
		*H ₂ SO ₄ -HNO ₃ digest, KMnO ₄ oxidation, FAAS using Hilger-Watts Atomspek and LDC Mercury Meter	
Fisheries and Marine Service, Inspection Branch (Freshwater Institute)	FMSIB	H ₂ SO ₄ -HNO ₃ digest, KMnO ₄ oxidation, Hot Block, Automated FAAS using PE 403 AAS.	17
		*H ₂ SO ₄ -HNO ₃ digest, KMnO ₄ oxidation, FAAS using PE 303 AAS	18
University of Rochester	U of R	NaOH dissolve, Cd reduction inorganic and total Hg by AAS using LDC Mercury Meter	19
Michigan State University	MSU	Acid digest, FAAS using Jarrell-Ash 800 AAS	20
Ontario Research Foundation	ORF	H ₂ SO ₄ digest, KMnO ₄ oxidation, FAAS using Techtron AA-120	13

* Method used prior to 1972

RESULTS:

The 1975 fish data consisted of results from two major surveys. The fish were collected by MNR in two distinct surveys:

Survey 1: those lakes that are directly on the Wabigoon-English River system or are part of its drainage basin. There were 2873 fish taken by MNR and analyzed by MOE for this survey.

Survey 2: this survey includes lakes that are both on and off the Wabigoon-English system. There were 2003 fish samples collected by MNR and analyzed by FMSIB for this survey.

Tables 3 to 17 show the mercury concentrations for each species from Survey 1, 1975. Some of these lakes had been sampled in previous years; where data is available it appears immediately following the 1975 data for that lake.

The mercury concentration data is presented with the mean, maximum, minimum, and the percent of the values greater than or equal to 0.5 ppm. This method of presentation suffers from the drawback that it does not indicate the relationship between mercury concentration and fish size, but it was the format in which most previous years' data was available.

TABLE 3

BALL LAKE - MERCURY IN FISH, 1975

(Lat/Long: 50°18'/94°00')

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
Cisco	5	2.16	1.91	2.76	1.36	100
Mooneye	49	0.77	0.80	2.82	0.16	78
Perch	11	0.47	1.57	2.18	0.37	91
Pike	42	3.49	4.02	10.70	0.89	100
Red Horse Sucker	10	3.53	1.99	4.69	0.49	90
Sauger	14	0.45	1.95	6.39	0.38	93
Smallmouth Bass	8	2.24	1.45	2.41	0.51	100
Walleye	58	2.06	1.58	4.26	0.41	95
Whitefish	44	2.69	0.71	2.54	0.15	59
White Sucker	38	2.67	1.33	3.00	0.26	82

TABLE 3-A.

BALL LAKE - PREVIOUS YEARS

1974 Species	N	Mean Wt. (lb).	Mercury Concentration (ppm)			% > 0.5 ppm
			Mean	Max.	Min.	
Cisco	2	2.44	0.68	0.89	0.48	50
Pike	32	5.25	2.95	7.95	0.54	100
Sauger	1	0.88	1.58	-	-	-
Smallmouth Bass	5	1.96	2.39	3.11	1.93	100
Walleye	50	2.61	2.45	4.42	0.94	100
Whitefish	28	3.21	0.78	3.25	0.13	36
<u>1972</u>						
Carp	2	3.74	7.29	10.72	3.86	100
Pike	10	4.10	7.53	16.09	0.98	100
Walleye	24	2.03	2.96	6.42	1.33	100
White Sucker	13	2.64	3.43	6.26	0.86	100
<u>1972</u>						
Pike	5	5.48	8.56	14.83	4.15	100
Smallmouth Bass	7	1.89	2.29	4.80	0.47	
Walleye	23	3.08	4.20	19.71	0.79	100
Whitefish	15	3.24	1.08	2.97	0.24	
<u>1972</u>						
Pike	20	-	3.65	-	-	-
Walleye	20	-	2.60	-	-	-
<u>1971</u>						
Mooneye	4	-	1.06	1.38	0.84	100
Pike	37	-	4.50	14.87	1.06	100
Sauger	4	-	2.96	3.24	2.10	100
Walleye	28	-	2.94	6.22	0.80	100
<u>1970</u>						
Pike	3	-	3.65	4.47	2.26	100
White Sucker	2	-	3.09	3.39	2.78	100

TABLE 4
BLUEBERRY LAKE - MERCURY IN FISH, 1975
 (Lat/Long: 50°09'/94°44')

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
Perch	41	0.18	0.12	0.22	0.06	0
Pike	89	2.16	0.71	3.02	0.17	64
Smallmouth Bass	2	0.60	0.60	0.90	0.30	50
Walleye	47	1.94	0.58	1.22	0.19	57
White Sucker	19	2.49	0.17	0.32	0.05	0

TABLE 4-A.

BLUEBERRY LAKE - PREVIOUS YEARS

1973 Species	N	Mean Wt. (lb).	Mercury Concentration (ppm)			% > 0.5 ppm
			Mean	Max.	Min.	
Pike	13	3.58	1.02	3.28	0.24	62
Smallmouth Bass	2	2.06	0.65	0.65	0.65	100
Walleye	25	2.54	0.80	1.29	0.31	88

TABLE 5
THE DALLES - MERCURY IN FISH, 1975
 (Lat/Long: 49°54'/94°33')

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
Bullhead	1	1.27	0.21	-	-	-
Ling	1	1.67	0.97	-	-	-
Mooneye	20	1.14	0.31	0.56	0.19	5
Pike	20	4.69	1.15	2.01	0.46	95
Red Horse Sucker	2	2.76	0.48	0.82	0.13	50
Sauger	15	0.30	0.74	0.99	0.40	86
Smallmouth Bass	9	1.49	0.54	1.04	0.30	44
Walleye	54	2.63	0.90	1.94	0.13	91
White Sucker	67	2.33	0.33	0.72	0.08	13

THE DALLES - PREVIOUS YEARS

1974 Species	N	Mean Wt. (lb).	Mercury Concentration (ppm)			% > 0.5 ppm
			Mean	Max.	Min.	
Bullhead	10	0.96	0.16	0.24	0.06	0
Mooneye	6	1.21	0.31	0.57	0.24	17
Perch	10	0.72	0.45	0.74	0.20	30
Pike	33	5.29	1.12	3.66	0.28	76
Smallmouth Bass	9	1.86	0.52	0.72	0.29	56
Walleye	45	2.36	0.84	10.43	0.32	60
<u>1972</u>						
Bullhead	51	0.94	0.24	0.75	0.10	4
Mooneye	6	1.22	0.36	0.78	0.18	17
Perch	13	0.98	0.66	1.05	0.37	69
Pike	23	5.07	1.12	1.89	0.50	100
Smallmouth Bass	22	1.43	0.95	1.75	0.38	91
Walleye	35	1.80	0.67	1.47	0.20	63
<u>1970</u>						
Pike	30	-	0.88	2.38	0.18	
Sauger	2	-	0.27	0.30	0.24	
Walleye	9	-	0.78	1.42	0.32	

TABLE 6
DELANEY LAKE - MERCURY IN FISH, 1975
(Lat/Long: 50°05'/94°03')

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	• Min.	
Lake Trout	31	4.14	0.27	0.55	0.14	3
Ling	27	2.19	0.44	0.68	0.10	26
Pike	11	5.75	0.48	0.75	0.12	56
Rock Bass	35	0.30	0.23	0.69	0.09	3
Smallmouth Bass	24	1.47	0.27	0.58	0.12	8
Walleye	2	2.42	0.87	1.16	0.58	100
Whitefish	18	6.14	0.14	0.35	0.08	0
White Sucker	52	1.21	0.09	0.25	0.03	0

TABLE 6-A.

DELANEY LAKE - PREVIOUS YEARS

1973 Species	N	Mean Wt. (lb).	Mercury Concentration (ppm)			% > 0.5 ppm
			Mean	Max.	Min.	
Lake Trout	34	4.90	0.42	0.63	0.21	15
Ling	7	3.06	0.25	0.37	0.17	0
Pike	30	5.04	0.47	1.01	0.24	30
Smallmouth Bass	12	1.86	0.24	0.31	0.19	0
Whitefish	4	5.47	0.06	0.11	0.03	0

TABLE 7

GOOSENECK LAKE - MERCURY IN FISH, 1975

(Lat/Long: 50°02'/94°48')

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
Cisco	44	0.09	0.31	0.72	0.14	9
Lake Trout	31	4.35	0.73	1.91	0.30	71
Pike	78	4.27	0.81	1.46	0.33	85
Red Horse Sucker	5	2.49	0.20	0.27	0.14	0
Rock Bass	1	0.16	0.46	-	-	-
Smallmouth Bass	33	2.19	0.98	1.69	0.53	100
White Sucker	48	2.51	0.18	0.50	0.05	2

TABLE 7-A.

GOOSENECK LAKE - PREVIOUS YEARS

1973 Species	N	Mean Wt. (lb).	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
Cisco	9	0.10	0.28	0.43	0.20	0
Lake Trout	14	4.25	0.70	1.91	0.17	36
Pike	9	3.78	1.24	1.79	0.67	100
Smallmouth Bass	7	2.28	1.06	1.52	0.67	100

TABLE 8

GRASSY NARROWS LAKE - MERCURY IN FISH, 1975

(Lat/Long: 50°09'/93°59')

Species	N	Mean Wt. (lb)	Mercury Concentration(ppm)			% >.5 ppm
			Mean	Max.	Min.	
Cisco	54	1.50	0.45	9.81	0.25	31
Mooneye	23	0.59	0.84	1.86	0.40	87
Muskie	1	12.78	6.81	-	-	-
Perch	4	0.41	1.21	2.00	0.74	100
Pike	44	3.44	2.81	6.32	0.73	100
Sauger	52	0.62	1.94	4.03	0.94	100
Walleye	52	1.86	1.63	2.65	0.46	98
Whitefish	18	2.63	0.47	2.47	0.14	22
White Sucker	30	2.09	0.76	1.53	0.20	83

-25-
TABLE 8A

GRASSY NARROWS LAKE - PREVIOUS YEARS

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>1974</u>						
Cisco	16	1.70	0.43	2.31	0.09	19
Pike	51	4.25	2.28	5.55	1.04	100
Sauger	4	1.08	2.11	2.53	1.42	100
Smallmouth Bass	1	0.88	1.03	-	-	-
Walleye	44	2.41	1.90	3.35	1.73	100
Whitefish	17	2.92	0.29	0.63	0.06	18
<u>1972</u>						
Pike	20	-	3.30	-	-	-
Walleye	19	-	2.08	-	-	-
<u>1970</u>						
Walleye	3	-	2.79	-	-	-
<u>1970</u>						
Pike	20	-	4.26	12.4	1.68	100
Sauger	5	-	3.12	3.67	2.08	100
Walleye	19	-	2.16	4.42	1.30	100

TABLE 9
GUN LAKE - MERCURY IN FISH, 1975
(Lat/Long: 49°57'/94°39')

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
Bullhead	2	0.81	0.24	0.24	0.23	0
Cisco	14	0.20	0.12	0.26	0.08	0
Mooneye	9	1.26	0.29	0.38	0.22	0
Perch	16	0.12	0.18	0.24	0.13	0
Pike	68	4.94	0.84	1.85	0.35	93
Sauger	3	0.42	0.67	0.70	0.64	100
Smallmouth Bass	2	1.69	0.54	0.69	0.38	50
Walleye	147	3.23	0.84	2.02	0.28	88
White Sucker	66	1.97	0.23	0.49	0.04	0

TABLE 9A

GUN LAKE - PREVIOUS YEARS

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>1974</u>						
Bullhead	1	1.38	0.21	-	-	-
Cisco	3	1.02	0.31	0.39	0.16	0
Muskie	1	6.06	0.46	-	-	-
Pike	48	4.72	0.88	1.57	0.33	90
Walleye	14	2.44	0.57	1.13	0.18	50
Whitefish	1	7.50	0.29	-	-	-
<u>1970</u>						
Cisco	1	-	0.54	-	-	-
Perch	1	-	0.42	-	-	-
Pike	8	-	1.40	2.39	0.96	100
Walleye	11	-	0.98	2.41	0.38	-
Whitefish	2	-	0.23	0.24	0.22	0
Walleye	115	1.69	0.72	1.80	0.31	71

TABLE 10
KEYS LAKE - MERCURY IN FISH, 1975
 (Lat/Long: 50°02'/94°01')

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
Cisco	3	0.65	0.25	0.41	0.10	0
Lake Trout	15	1.71	0.41	0.95	0.20	20
Ling	10	1.10	0.52	0.93	0.33	40
Whitefish	15	2.17	0.24	0.52	0.18	7
White Sucker	38	1.07	0.10	0.23	0.04	0

TABLE 10A

KEYS LAKE - PREVIOUS YEARS

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
1973						
Lake Trout	29	3.58	0.41	0.61	0.01	14
Ling	5	2.75	0.41	0.60	0.29	20
Whitefish	28	2.74	0.17	0.36	0.09	0

TABLE 11
SAND LAKE - MERCURY IN FISH, 1975
(Lat/Long: 50°05'/94°39')

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
Cisco	26	1.50	0.22	0.55	0.08	4
Crappie	2	1.04	0.31	0.42	0.20	0
Muskie	1	19.27	3.15	-	-	-
Perch	44	0.21	0.19	0.55	0.11	5
Pike	21	7.23	1.08	2.76	0.19	86
Sauger	1	0.57	0.96	-	-	-
Walleye	50	3.50	0.77	2.06	0.20	88
Whitefish	8	0.72	0.08	0.12	0.06	0
White Sucker	40	2.56	0.32	0.67	0.06	13

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TABLE 11-A

SAND LAKE - PREVIOUS YEARS

Species	N	Mean Wt. (lb)	Mercury Concentration(ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>1975</u>						
Cisco	47	2.27	0.19	0.37	0.06	0
<u>1974</u>						
Muskie	1	7.50	0.61	-	-	-
Mooneye	1	1.63	0.37	-	-	-
Pike	51	4.42	0.69	2.26	0.25	67
Walleye	48	3.01	0.59	1.86	0.31	50
White Sucker	29	2.33	0.10	0.41	0.01	0
<u>1973</u>						
Catfish	1	1.00	0.07	-	-	-
Perch	1	0.63	0.42	-	-	-
Pike	33	4.81	1.38	3.49	0.48	91
Smallmouth Bass	7	1.28	0.49	0.78	0.26	29
Walleye	60	3.17	1.12	1.93	0.38	90
Whitefish	4	3.22	0.38	0.80	0.04	25
<u>1970</u>						
Cisco	1	-	0.42	-	-	-
Pike	1	-	1.04	-	-	-
Walleye	1	-	1.39	-	-	-
Whitefish	7	-	0.22	0.35	0.19	0
White Sucker	1	-	0.40	-	-	-

TABLE 12

SEPARATION LAKE - MERCURY IN FISH, 1975

(Lat/Long: 50°10'/94°24')

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
Cisco	14	1.82	0.60	1.01	0.26	86
Ling	3	1.96	1.82	3.55	0.89	100
Mooneye	20	0.93	1.21	4.27	0.42	85
Perch	1	0.50	0.92	-	-	-
Pike	29	2.83	2.84	5.89	0.91	100
Red Horse Sucker	11	2.74	1.19	2.83	0.58	100
Sauger	5	0.82	3.18	4.33	2.33	100
Smallmouth Bass	4	1.16	1.35	1.77	0.92	100
Walleye	51	1.95	2.99	4.58	1.18	100
Whitefish	10	2.29	0.55	0.82	0.32	53
White Sucker	55	2.46	1.05	2.09	0.32	96

TABLE 12-A

SEPARATION LAKE - PREVIOUS YEARS

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>1974</u>						
Cisco	2	1.87	0.61	0.68	0.53	100
Pike	50	3.95	2.96	6.52	0.81	100
Rock Bass	1	0.63	1.95	-	-	-
Smallmouth Bass	4	1.72	1.95	2.34	1.71	100
Walleye	50	2.25	2.77	4.51	0.76	100
Whitefish	28	3.10	0.36	0.65	0.13	11
<u>1972</u>						
Pike	20	-	4.05	-	-	-
Walleye	20	-	2.93	-	-	-
<u>1970</u>						
Pike	20	-	5.00	14.84	1.42	100
Sauger	3	-	4.59	5.70	3.58	100
Walleye	20	-	2.99	4.53	1.79	100

TABLE 13

SNOOK LAKE - MERCURY IN FISH, 1975

(Lat/Long: 50°11'/94°41')

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
Cisco	21	0.09	0.27	0.37	0.16	0
Lake Trout	48	2.85	0.76	2.33	0.35	88
Pike	42	3.72	0.70	1.11	0.24	79
White Sucker	25	2.67	0.24	0.51	0.08	4

TABLE 13-A

SNOOK LAKE - PREVIOUS YEARS

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>1973</u>						
Lake Trout	30	2.26	0.68	1.62	0.31	57
Pike	16	3.61	0.83	1.92	0.29	69

TABLE 14
TETU LAKE - MERCURY IN FISH, 1975
(Lat/Long: 50°11'/95°02')

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
Ling	4	2.74	1.99	2.32	1.62	100
Perch	5	0.26	0.92	1.61	0.49	80
Pike	32	4.34	2.87	10.63	0.99	100
Sauger	16	0.44	1.24	2.71	0.69	100
Walleye	50	2.30	1.86	3.98	0.58	100
Whitefish	16	2.75	0.63	1.26	0.18	69
White Sucker	11	2.43	1.23	1.79	0.43	91

TABLE 14-A

TETU LAKE - PREVIOUS YEARS

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>1974</u>						
Bullhead	4	0.97	0.10	0.13	0.04	0
Perch	9	0.64	0.11	0.22	0.06	0
Pike	48	3.60	1.74	6.51	0.22	85
Smallmouth Bass	10	1.79	0.61	1.17	0.20	60
Walleye	50	2.41	1.45	2.70	0.40	98
Whitefish	14	2.28	0.55	2.52	0.11	36
<u>1973</u>						
Catfish	6	1.24	0.40	0.73	0.17	17
Perch	2	0.72	1.33	1.57	1.09	100
Pike	58	4.89	2.73	6.39	0.19	98
Rock Bass	3	0.42	1.24	1.37	1.08	100
Smallmouth Bass	29	1.97	1.28	3.14	0.09	93
Walleye	47	1.93	1.67	2.97	0.35	96
Whitefish	8	2.86	0.45	1.05	0.12	38
<u>1972</u>						
Pike	20	-	2.65	-	-	-
<u>1970</u>						
Ling	1	-	1.87	-	-	-
Mooneye	1	-	0.91	-	-	-
Pike	22	-	3.60	9.50	0.64	100
Sauger	1	-	2.63	-	-	-
Walleye	4	-	1.79	2.24	0.50	100
<u>1970</u>						
Pike	1	5.81	5.25	-	-	-
Smallmouth Bass	1	3.96	0.55	-	-	-
Walleye	1	2.62	1.50	-	-	-
White Sucker	1	1.76	1.00	-	-	-

TABLE 15

TOOTHPICK LAKE - MERCURY IN FISH, 1975

(Lat/Long: 50°07'/94°08')

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
Cisco	50	0.17	0.13	0.19	0.09	0
Ling	5	4.07	0.57	0.78	0.40	60
Pike	56	2.56	0.83	1.57	0.19	82
Smallmouth Bass	3	1.72	0.75	1.33	0.46	33
Walleye	44	2.23	0.73	1.60	0.42	89
White Sucker	14	2.60	0.25	0.48	0.06	0

TABLE 15-A

TOOTHPICK LAKE - PREVIOUS YEARS

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>1973</u>						
Pike	30	2.61	1.02	1.63	0.42	90
Walleye	25	2.66	0.86	1.41	0.36	84

TABLE 16
UMFREVILLE (E) LAKE - MERCURY IN FISH, 1975
 (Lat/Long: 50⁰18'/94⁰45')

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
Ling	2	2.75	1.63	1.65	1.61	100
Mooneye	1	0.81	1.39	-	-	-
Pike	4	4.03	2.85	3.95	1.45	100
Sauger	1	0.37	1.59	-	-	-
Walleye	49	2.72	2.06	6.04	0.92	100
Whitefish	5	3.23	0.56	0.74	0.44	40

TABLE 16-A

UMFREVILLE (E) LAKE - PREVIOUS YEARS

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>1974</u>						
Pike	46	4.57	3.99	8.61	1.83	100
Walleye	50	3.33	2.48	5.71	0.81	100
Whitefish	29	3.03	0.50	0.99	0.10	48
<u>1972 (includes Umfreville (W) data)</u>						
Mooneye	3	1.19	1.65	2.53	0.98	100
Perch	2	0.69	1.05	1.21	0.89	100
Pike	53	3.70	4.26	8.90	0.99	100
Rock Bass	1	0.65	1.57	-	-	-
Walleye	114	2.42	3.15	9.02	0.74	100
Whitefish	13	1.67	0.65	1.49	0.11	62
<u>1970</u>						
Ling	2	-	3.01	3.74	2.39	100
Mooneye	1	-	2.55	-	-	-
Pike	4	-	2.21	3.15	0.31	-
Sturgeon	2	-	0.98	1.88	0.07	-
Walleye	1	-	2.60	-	-	-
White Sucker	3	-	1.02	1.22	0.80	100

TABLE 17
UMFREVILLE (W) LAKE - MERCURY IN FISH, 1975
(Lat/Long: 50°18'/94°45')

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
Cisco	1	2.33	0.56	-	-	-
Ling	12	1.96	1.51	3.53	0.47	92
Pike	10	5.09	3.35	6.09	1.16	100
Sauger	7	0.34	1.34	2.73	0.48	86
Walleye	80	2.78	1.99	4.85	0.70	100
Whitefish	41	2.63	0.47	0.82	0.29	32
White Sucker	12	3.41	0.99	1.68	0.48	92

TABLE 17-A

UMFREVILLE (W) LAKE - PREVIOUS YEARS

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>1974</u>						
Perch	2	0.59	0.48	0.54	0.41	50
Pike	18	1.98	1.70	5.01	0.76	100
Rock Bass	1	0.19	0.51	-	-	-
Sauger	1	0.69	2.50	-	-	-
Walleye	31	2.47	1.22	3.81	0.54	100
Whitefish	5	5.03	0.60	0.74	0.45	80
<u>1972</u>						
See as part of Umfreville (E) Lake						
<u>1970</u>						
Ling	2	-	3.06	3.74	2.39	100
Pike	20	-	4.03	9.12	0.76	100
Sauger	2	-	3.40	4.48	3.13	100
Walleye	11	-	3.33	5.02	2.09	100
Whitefish	3	-	1.03	1.43	0.78	100

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TABLE 18

CLAY LAKE - MERCURY IN FISH

(Lat/Long: 50°04'/93°30')

Species	N	Mean Wt. (lb)	Mercury Concentration(ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>1975</u>						
Cisco	5	1.32	2.92	3.35	2.30	100
Ling	6	2.55	5.44	6.65	3.95	100
Perch	2	0.06	0.93	1.15	0.70	100
Pike	15	3.06	5.18	11.20	2.32	100
Sauger	5	0.87	4.67	5.90	3.80	100
Walleye	7	2.60	5.98	8.70	4.60	100
Whitefish	2	2.59	2.01	2.31	1.71	100
<u>1974</u>						
Pike	36	-	4.22	10.9	0.36	-
Whitefish	20	-	1.26	2.58	0.45	-
White Sucker	21	-	1.28	3.74	0.50	100
<u>1972</u>						
Pike	25	-	3.03	-	-	-
Walleye	24	-	7.67	-	-	-
Whitefish	20	-	8.87	-	-	-
White Sucker	20	-	2.24	-	-	-
<u>1970</u>						
Ling	4	3.73	21.95	24.8	19.1	100
Walleye	5	2.97	15.74	19.6	12.3	100
White Sucker	5	1.56	3.13	3.75	2.29	100
<u>1970</u>						
Pike	28	-	9.24	14.9	3.79	100
Walleye	274	2.10	12.1	24.0	1.2	100
Whitefish	20	-	3.58	12.57	0.15	-
White Sucker	20	-	3.83	7.97	1.68	100

Survey 2 in 1975 covered many lakes that are eventually drained by the Wabigoon-English system. Some of these lakes had been sampled in previous years. Table 19 shows the mercury data for these lakes, for all species and years for which data was available.

TABLE 19

OFF-SYSTEM LAKES - MERCURY LEVELS

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>Buck Lake - 1975</u> 50°04'/94°02'						
Lake Trout	16	4.63	1.42	2.55	0.76	100
White Sucker	4	1.84	0.13	0.17	0.10	0
<u>Chase Lake - 1975</u> 50°37'/94°57'						
Cisco	41	0.60	0.10	0.15	0.07	0
Pike	44	2.77	0.54	1.43	0.13	50
Walleye	53	1.33	0.47	1.02	0.10	42
Whitefish	1	1.39	0.07	-	-	-
White Sucker	50	2.27	0.11	0.29	0.03	0
<u>Eagle Lake - 1975</u> 50°40'/94°53'						
Cisco	11	1.63	0.26	0.41	0.15	0
Ling	10	2.51	0.61	0.87	0.36	80
Perch	6	0.38	0.12	0.21	0.09	0
Pike	36	2.38	0.70	1.80	0.20	61
Walleye	50	1.98	0.93	1.45	0.49	92
Whitefish	51	2.72	0.10	0.19	0.06	0
White Sucker	50	0.59	0.20	0.46	0.06	0
<u>1971</u>						
Pike	114	3.00	0.94	2.03	0.20	84
Walleye	115	1.55	0.88	1.60	0.04	87
<u>Eden Lake - 1975</u> 50°40'/94°59'						
Lake Trout	39	2.96	0.33	0.80	0.09	5
Ling	21	2.73	0.38	0.47	0.18	0
Whitefish	50	1.44	0.06	0.14	0.02	0
White Sucker	8	2.67	0.10	0.19	0.04	0

TABLE 19
cont.

OFF-SYSTEM LAKES - MERCURY LEVELS

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>Favel Lake - 1975</u> <u>50°00'/94°00'</u>						
Lake Trout	28	2.75	0.46	1.52	0.20	14
Ling	7	2.79	0.91	1.14	0.73	100
Muskie	1	5.11	0.47	-	-	-
Whitefish	50	1.63	0.17	0.40	0.09	0
White Sucker	4	3.87	0.24	0.33	0.17	0
<u>Marshaluk Lake - 1975</u> <u>50°22'/93°35'</u>						
Cisco	5	1.64	0.10	0.13	0.06	0
Whitefish	44	3.06	0.04	0.13	0.01	0
<u>Maynard Lake - 1975</u> <u>50°22'/93°54'</u>						
Mooneye	6	0.81	0.14	0.21	0.09	0
Muskie	1	1.13	0.21	-	-	-
Pike	47	2.72	0.51	1.04	0.25	34
Sauger	5	0.43	0.40	0.69	0.24	20
Walleye	50	1.29	0.38	0.74	0.20	14
<u>Maynard Lake - 1972</u>						
Pike	3	-	0.54	0.66	0.43	-
Walleye	3	-	0.33	0.39	0.29	-
<u>Maynard Lake - 1972</u>						
Pike	119	4.10	0.55	1.40	0.18	44
Walleye	118	1.50	0.39	0.90	0.19	8
<u>Maynard Lake - 1970</u>						
Pike	5	-	0.34	0.43	0.16	-
Walleye	5	-	0.31	0.37	0.29	-
<u>Maynard Lake - 1970</u>						
Pike	4	2.97	1.30	3.44	0.47	80
Walleye	6	1.92	0.31	0.41	0.24	0

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TABLE 19

cont.

OFF-SYSTEM LAKES - MERCURY LEVELS

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>Meandering Lake - 1975</u> <u>50°07'/93°55'</u>						
Pike	48	4.32	1.03	2.3	0.33	90
Walleye	45	3.12	1.08	2.33	0.40	93
White Sucker	20	2.77	0.23	0.80	0.06	5
<u>Oak Lake - 1975</u> <u>50°26'/93°50'</u>						
Cisco	43	1.16	0.10	0.28	0.01	0
Mooneye	33	0.86	0.16	0.28	0.10	0
Pike	20	2.98	0.53	1.34	0.27	35
Walleye	28	1.86	0.42	0.86	0.11	18
Whitefish	24	1.85	0.11	0.17	0.05	0
<u>Oak Lake - 1973</u>						
Pike	1	-	0.32	-	-	-
Walleye	1	-	0.34	-	-	-
<u>Oak Lake - 1971</u>						
Pike	104	1.76	0.50	1.09	0.13	37
Walleye	113	3.35	0.39	1.07	0.03	15
<u>Oak Lake - 1970</u>						
Pike	6	3.13	0.59	0.85	0.49	-
Walleye	5	1.63	0.49	0.57	0.33	-

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TABLE 19

cont.

OFF-SYSTEM LAKES - MERCURY LEVELS

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>Roughrock Lake - 1975</u> <u>50°06'/94°46'</u>						
Cisco	8	0.57	0.14	0.18	0.09	0
Ling	3	3.32	0.39	0.49	0.23	0
Mooneye	2	1.24	0.23	0.24	0.22	0
Perch	7	0.37	0.27	0.38	0.16	0
Pike	50	4.41	0.77	1.60	0.24	68
Rockbass	1	0.37	0.33	-	-	-
Sauger	1	0.15	0.20	-	-	-
Smallmouth Bass	4	1.75	1.05	1.19	0.98	100
Walleye	49	3.06	0.86	2.04	0.28	78
Whitefish	1	7.25	0.22	-	-	-
White Sucker	50	2.60	0.31	0.57	0.07	2
<u>Routine Lake - 1975</u>						
Cisco	25	0.78	0.24	0.31	0.19	0
Perch	3	0.28	0.14	0.15	0.14	0
Pike	28	4.25	0.85	1.17	0.23	64
Smallmouth Bass	11	1.99	0.60	1.21	0.31	54
Walleye	37	2.27	0.90	1.53	0.42	85
Whitefish	2	3.67	0.18	0.20	0.16	0
<u>Snowshoe Lake - 1975</u> <u>50°34'/95°07'</u>						
Cisco	16	0.41	0.17	0.23	0.09	0
Ling	19	3.96	0.51	0.74	0.30	47
Pike	38	4.12	0.92	1.53	0.36	82
Redhorse Sucker	1	2.33	0.23	-	-	0
Walleye	39	1.77	0.77	1.25	0.34	77
Whitefish	39	2.50	0.09	0.20	0.03	0
White Sucker	45	2.13	0.13	0.29	0.04	0
<u>Snowshoe Lake - 1972</u>						
Pike	92	3.86	0.85	2.17	0.17	80
Walleye	95	1.44	0.71	1.32	0.33	71

TABLE 19
cont.

OFF-SYSTEM LAKES - MERCURY LEVELS

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>Sup Lake - 1975</u> <u>50°17'/93°32'</u>						
Pike	3	9.34	1.39	1.74	0.82	100
Walleye	50	2.26	0.51	1.02	0.14	34
Whitefish	51	1.55	0.06	0.38	0.01	0
<u>Toole Lake - 1975</u> <u>50°22'/93°32'</u>						
Pike	4	3.95	0.76	1.30	0.43	50
Walleye	30	2.78	0.72	1.28	0.41	73
Whitefish	43	2.69	0.10	0.35	0.03	0
White Sucker	10	2.62	0.11	0.23	0.06	0
<u>Trapline Lake - 1975</u> <u>50°30'/94°55'</u>						
Cisco	21	0.50	0.22	0.32	0.10	0
Pike	15	3.16	1.00	2.43	0.40	60
Walleye	56	1.50	0.90	1.71	0.39	84
White Sucker	50	2.34	0.15	0.35	0.04	0

MISCELLANEOUS NORTHWESTERN ONTARIO LAKES

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>Bruce Lake - 1974</u> 50°50'/93°20'						
Mooneye	2	1.19	0.13	0.15	0.12	0
Pike	50	0.82	0.25	0.57	0.13	4
Sauger	13	0.24	0.29	0.55	0.17	8
Walleye	42	0.92	0.32	0.77	0.07	12
<u>Colonna Lake - 1973</u> 50°08'/93°50'						
Pike	31	2.65	0.38	0.57	0.00	10
Walleye	23	1.96	0.37	0.88	0.00	13
<u>Confusion Lake - 1974</u> 50°39'/94°10'						
Lake Trout	17	2.11	1.00	2.04	0.09	71
Pike	44	1.39	0.32	1.24	0.13	11
Walleye	59	1.25	0.37	1.05	0.09	17
Whitefish	8	1.99	0.13	0.29	0.02	0
<u>Confusion Lake - 1972</u>						
Walleye	95	2.06	0.58	1.13	0.26	52
<u>Confusion Lake - 1971</u>						
Pike	27	4.36	0.84	1.24	0.42	89
<u>Cygnet Lake - 1973</u> 50°02'/94°54'						
Cisco	10	1.38	0.05	0.08	0.03	0
Pike	19	5.93	0.33	0.58	0.18	5
Walleye	29	2.42	0.23	0.70	0.15	7

TABLE 20
cont.

MISCELLANEOUS NORTHWESTERN ONTARIO LAKES

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% > .5 ppm
			Mean	Max.	Min.	
<u>Dinorwic Lake - 1972</u> 49°40' / 92°32'						
Walleye	24	2.09	0.57	1.64	0.25	50
<u>Dinorwic Lake - 1971</u>						
Walleye	89	1.80	0.54	1.64	0.20	37
Pike	100	4.40	0.60	1.19	0.17	55
<u>Indian Lake - 1975</u> 50°13' / 94°04'						
Pike	1	2.03	5.61	-	-	-
<u>Indian Lake - 1972</u>						
Perch	2	0.51	1.74	2.83	0.65	100
Pike	22	2.70	4.00	13.19	0.59	100
Walleye	38	1.37	1.66	3.11	0.48	
<u>Indian Lake - 1971</u>						
Pike	18	-	0.55	1.28	0.29	-
Walleye	3	-	0.41	0.44	0.39	-
Whitefish	1	-	0.13	-	-	-
<u>Indian Lake - 1970</u>						
Walleye	5	2.36	2.71	3.10	2.39	..
<u>Long Legged Lake 1972</u> 50°40' / 94°15'						
Pike	100	4.20	0.64	1.43	0.21	60
Walleye	99	1.55	0.53	1.28	0.20	37
<u>Long Legged Lake - 1971</u>						
Lake Trout	1	-	1.11	-	-	-
Pike	3	-	0.69	0.90	0.53	100
Walleye	5	-	0.85	1.03	0.57	100

TABLE 20
cont.

MISCELLANEOUS NORTHWESTERN ONTARIO LAKES

Species	N	Mean Wt. (lb)	Mercury Concentration(ppm)			%>.5 ppm
			Mean	Max.	Min.	
<u>Long Legged Lake - 1970</u>						
Walleye	5	1.50	0.67	0.81	0.49	80
<u>Lount Lake - 1972</u> 50°10'/94°17'						
Pike	4	-	3.69	5.53	1.60	100
Walleye	3	-	2.23	3.11	1.82	100
<u>Pistol Lake - 1975</u> 94°42'/49°58'						
Pike	4	-	0.96	1.3	0.64	100
Walleye	2	-	0.74	0.74	0.73	100
Whitefish	4	-	0.12	0.14	0.07	0
<u>Portal Lake - 1973</u> 50°19'/93°37'						
Pike	14	1.47	0.46	1.04	0.10	36
Walleye	26	1.52	0.44	0.90	0.22	31
Whitefish	26	2.36	0.19	0.93	0.03	4
<u>Roger Lake - 1972</u> 50°28'/94°20'						
Pike	53	3.43	0.80	1.81	0.19	66
Walleye	102	2.35	1.06	3.33	0.42	96
<u>Roger Lake - 1970</u>						
Pike	4	3.11	0.71	1.15	0.33	-
Walleye	10	1.83	0.66	0.82	0.59	-

TABLE 20
cont.

MISCELLANEOUS NORTHWESTERN ONTARIO LAKES

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>Rowan Lake - 1972</u> 49°18'/93°32'						
Lake Trout	2	4.47	0.31	0.32	0.30	0
Muskie	2	13.88	0.57	0.72	0.42	50
Pike	163	2.81	0.32	0.69	0.15	2
Walleye	111	4.08	0.77	1.79	0.09	85
Whitefish	8	1.77	0.09	0.11	0.06	0
<u>Rowdy Lake - 1971</u> 50°33'/94°29'						
Pike	94	3.90	0.98	2.07	0.27	85
Walleye	116	1.65	0.77	1.77	0.13	70
<u>Rowdy Lake - 1970</u>						
Pike	3	2.98	0.82	1.02	0.47	-
Walleye	5	1.54	0.76	0.98	0.60	100
<u>Scotty Lake - 1972</u> 50°20'/94°03'						
Lake Trout	4	4.18	0.51	1.00	0.20	-
Pike	27	3.08	0.82	2.06	0.16	-
S.M. Bass	1	1.50	4.48	-	-	-
Walleye	3	1.83	1.52	3.27	0.42	-
<u>Scotty Lake - 1970</u>						
Pike	3	7.40	0.97	1.63	0.57	100
Walleye	3	3.67	0.71	1.12	0.50	100
<u>Sydney Lake - 1972</u> 50°40'/94°25'						
Whitefish	18	-	0.11	-	-	-

TABLE 20
cont.

MISCELLANEOUS NORTHWESTERN ONTARIO LAKES

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% >.5 ppm
			Mean	Max.	Min.	
<u>Sydney Lake - 1971</u>						
Pike	88	3.74	0.53	1.42	0.19	38
Walleye	99	1.81	0.38	1.06	0.13	15
<u>Sydney Lake - 1970</u>						
Lake Trout	4	4.04	0.52	1.05	0.31	-
Pike	4	2.07	0.52	0.60	0.47	-
Walleye	6	1.88	0.47	0.65	0.37	-
<u>Tide Lake - 1975</u> 50°18'/93°59'						
Pike	1	2.59	12.13	-	-	-
<u>Tide Lake - 1970</u>						
Pike	4	4.20	3.74	4.88	2.91	100
Walleye	10	5.65	3.39	12.70	0.28	-
<u>Caribou Falls - 1975</u>						
Pike	2	-	1.2	1.3	1.2	100
Walleye	3	-	2.3	2.9	1.4	100
<u>Wabigoon - 1971</u> 49°45'/92°45'						
Pike	124	4.55	0.66	1.64	0.15	-
Walleye	98	3.02	0.63	1.63	0.17	-
<u>Wabigoon - 1970</u>						
Cisco	1	-	0.30	-	-	-
Ling	8	-	0.30	0.41	0.18	0
Pike	11	-	0.76	1.05	0.50	100
R.H. Sucker	1	-	0.95	-	-	-
Walleye	4	-	0.55	0.68	0.20	-

TABLE 20
cont.MISCELLANEOUS NORTHWESTERN ONTARIO LAKES

Species	N	Mean Wt. (lb)	Mercury Concentration (ppm)			% > .5 ppm
			Mean	Max.	Min.	
Whitefish	4	-	0.11	0.13	0.07	0
White Sucker	7	-	0.33	0.55	0.15	-
<hr/>						
<u>Wabigoon - 1970</u>						
Pike	4	4.92	1.37	1.88	0.94	100
Walleye	7	2.74	0.78	1.10	0.60	100
<hr/>						
<u>Wabigoon R. (between Clay and Ball) - 1972</u>						
50°07'/93°40'						
Mooneye	3	1.08	2.68	3.44	1.67	100
Perch	1	0.51	5.68	-	-	-
Pike	5	2.69	4.57	11.87	1.37	100
Sauger	1	0.75	13.54	-	-	-
Walleye	14	1.26	3.66	7.77	0.88	100
Whitefish	21	2.69	1.54	7.08	0.06	-
White Sucker	3	2.58	3.46	3.92	1.57	100
<hr/>						
<u>Wabigoon R. (between Clay and Ball) - 1972</u>						
Carp	2	3.13	3.85	4.71	2.99	100
Mooneye	6	1.41	6.00	7.83	4.19	100
Pike	4	1.74	6.69	10.16	4.26	100
Walleye	17	2.05	5.42	15.81	1.25	100
Whitefish	25	2.22	2.18	8.19	0.08	-
White Sucker	25	2.47	3.63	6.48	1.97	100
<hr/>						
<u>Wabigoon R. (between Clay and Ball) - 1970</u>						
Pike	3	3.43	15.17	27.8	8.57	100
Walleye	4	2.10	6.80	10.4	0.50	100
White Sucker	3	1.64	4.19	8.9	0.64	100

DISCUSSION

I: DATA INTERPRETATION

A complication arises in comparing the average mercury concentration in fish from one lake to another, because for most species in most lakes, the concentration of mercury in fish muscle increases with fish size. Because of this, valid comparisons of mean mercury concentrations can only be made between fish populations with approximately equal mean lengths or weights. In this study there were considerable size differences from one lake to another for most species. However, for some of the more common species, there was often sufficient data from each lake to formulate the relationship between weight or length and the mercury concentration. Using the results of these regression analyses, it was possible to compare the mercury concentration in fish of equal size from lake to lake and from year to year.

This normalization of mercury concentration data was done for three of the most common species in this survey (pike, walleye, and whitefish). The lengths selected for the normalization were 20 inches for walleye and whitefish, and 25 inches for pike.

II: ON-SYSTEM LAKES VS OFF-SYSTEM LAKES

This report provides summary information on over 11,000 fish representing 19 species (see Appendix 1) from 47 lakes in northwestern Ontario. Table 21 summarizes the mean mercury concentrations for the most heavily represented species.

TABLE 21: MERCURY MEANS OF SELECTED SPECIES IN THE STUDY AREA

LAKE	SPECIES												
	Cisco	Lake Trout	Ling	Mooneye	Perch	Pike	Redhorse Sucker	Rock Bass	Sauger	Smallmouth Bass	Walleye	Whitefish	White Sucker
Ball	X			+	X		X	X	X	X	+	X	
Blueberry				0	+				+	+		0	
Bruce				0	0			0		0			
Buck		X											
Chase	0				+					0	0	0	
Clay					+								
Colonna					0					0			
Confusion		X			0					0			
Cygnat	0				0					0			
Delaney		0	0		0	0				+	0	0	
Dinorwic					+					+			
Eagle	0			+	0	+				+	0	0	
Eden		0	0								0	0	
Favel		0	+										
Gooseneck	0	+			+	0	0		+			0	
Grassy Narrows	0			+	X			X		X	0	+	
Gun	0			0	0	+		+	+	+		0	
Indian					X					X			
Keys	0	0	+								0	0	
Long-legged					+					+			
Lount													
Marshalluk	0											0	
Maynard				0	+			0		0			
Meandering					X					X		0	
Oak	0			0		+				0	0		
Pistol					+					+	0		
Roger					+					X			
Roughrock	0		0	0	0	+	0	0	X	+	0	0	
Routine	+				0	+			+	+	0		
Rowan		0			0					+	0		
Rowdy					+					+			
Sand	0			0	0	X		+		+	0	0	
Separation	+		X	X	+		X		X		+	X	
Scotty		+			+					X			
Snook	0	+			+							0	
Snowshoe	0		+		+	0				+	0	0	
Sup					X					+	0		
Sydney		+			+					0	0		
Tetu			X	+	+	0	X	+	X	+	X		
The Dalles			+	0		X	0	+	+	+		0	
Tide													
Toole					+					+	0	0	
Toothpick	0		+		+			+	+			0	
Trapline	0				X					+		0	
Umfreville (E)			X	X			X				+		
Umfreville (W)	+		X	0			+	X		X	0	+	
Wabigoon	0		0		+	+				+	0	0	
Wabigoon River													

SYMBOL

0

+

X

SYMBOL

0

+

X



MEAN Hg (ppm)

<0.5

0.5 - 1.0

1.0 - 2.0

>2.0

The highest mercury values are found in fish from lakes on the Wabigoon-English River system. Figures 2 and 3 are maps of the study area, showing average mercury levels for pike and walleye, using the most recent data available. It can be seen that the average background mercury concentration for fish from this area is generally less than 1 ppm, but those species of fish from lakes directly on the Wabigoon-English system are always greater than 1 ppm, and generally exceed 2 ppm. Species averages in excess of 2 ppm are found only on fish from lakes directly on the system. The geographical distribution of highly contaminated pike and walleye indicates that the origin of the mercury contamination in the system occurs downstream of Lake Wabigoon on the Wabigoon River, the chlor-alkali plant in Dryden being the most obvious source.

The normalized mercury levels for 25 inch pike, 20 inch walleye and 20 inch whitefish from the on-system lakes are shown in Table 22. The lakes are listed in sequence downstream from Dryden.

In the off-system lakes, mean mercury values for these three species were always lower than for the on-system lakes. Table 23 shows the normalized mercury levels for pike, walleye, and whitefish from off-system lakes.

In Figures 4 and 5, the normalized mercury concentrations in pike and walleye are plotted against the distance downstream of Dryden. These graphs show that fish from the first location of capture (Clay Lake) are highly contaminated by mercury, and that there is a general trend towards decreased but still elevated levels of mercury in fish from lakes further down the system.

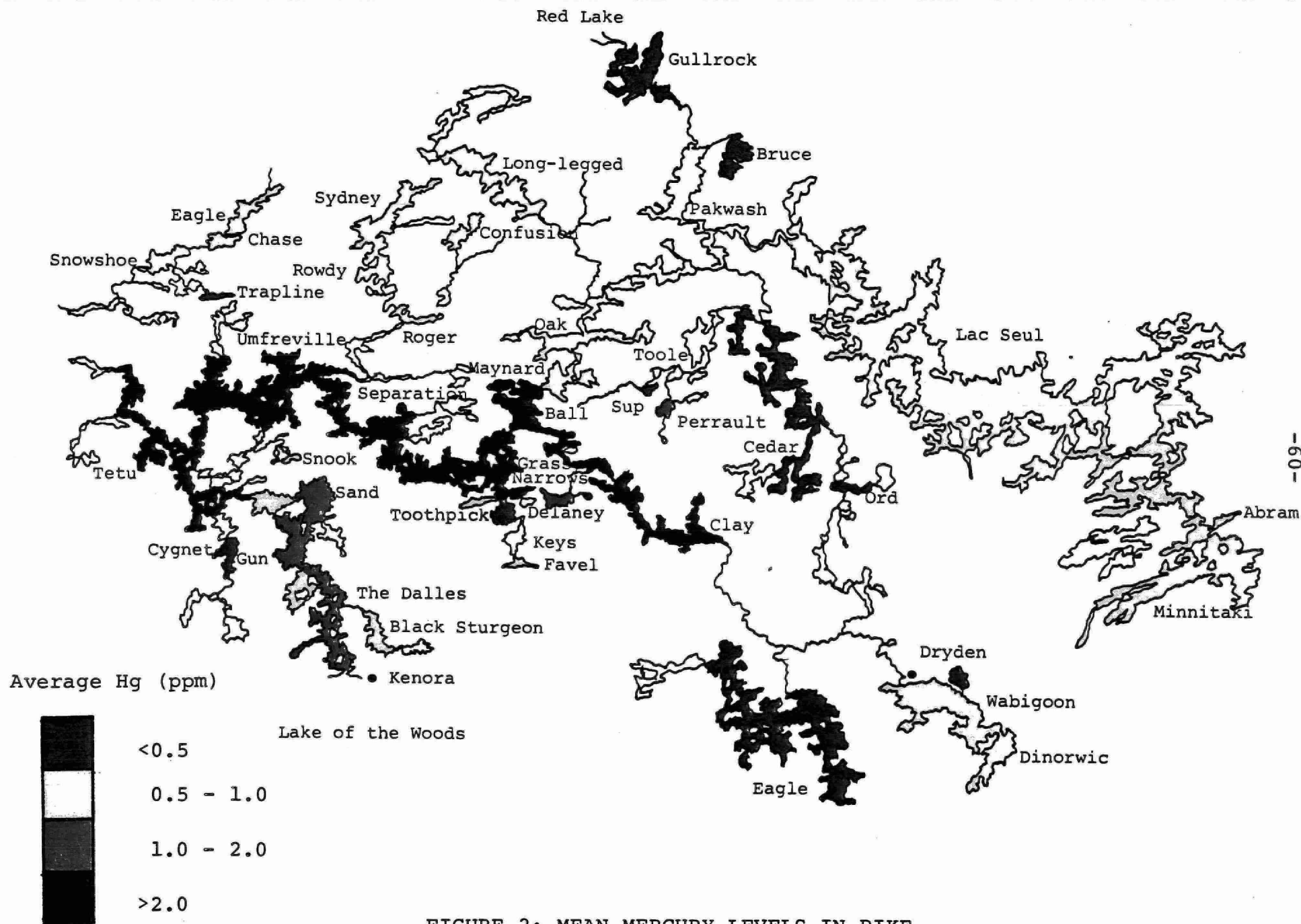


FIGURE 2: MEAN MERCURY LEVELS IN PIKE

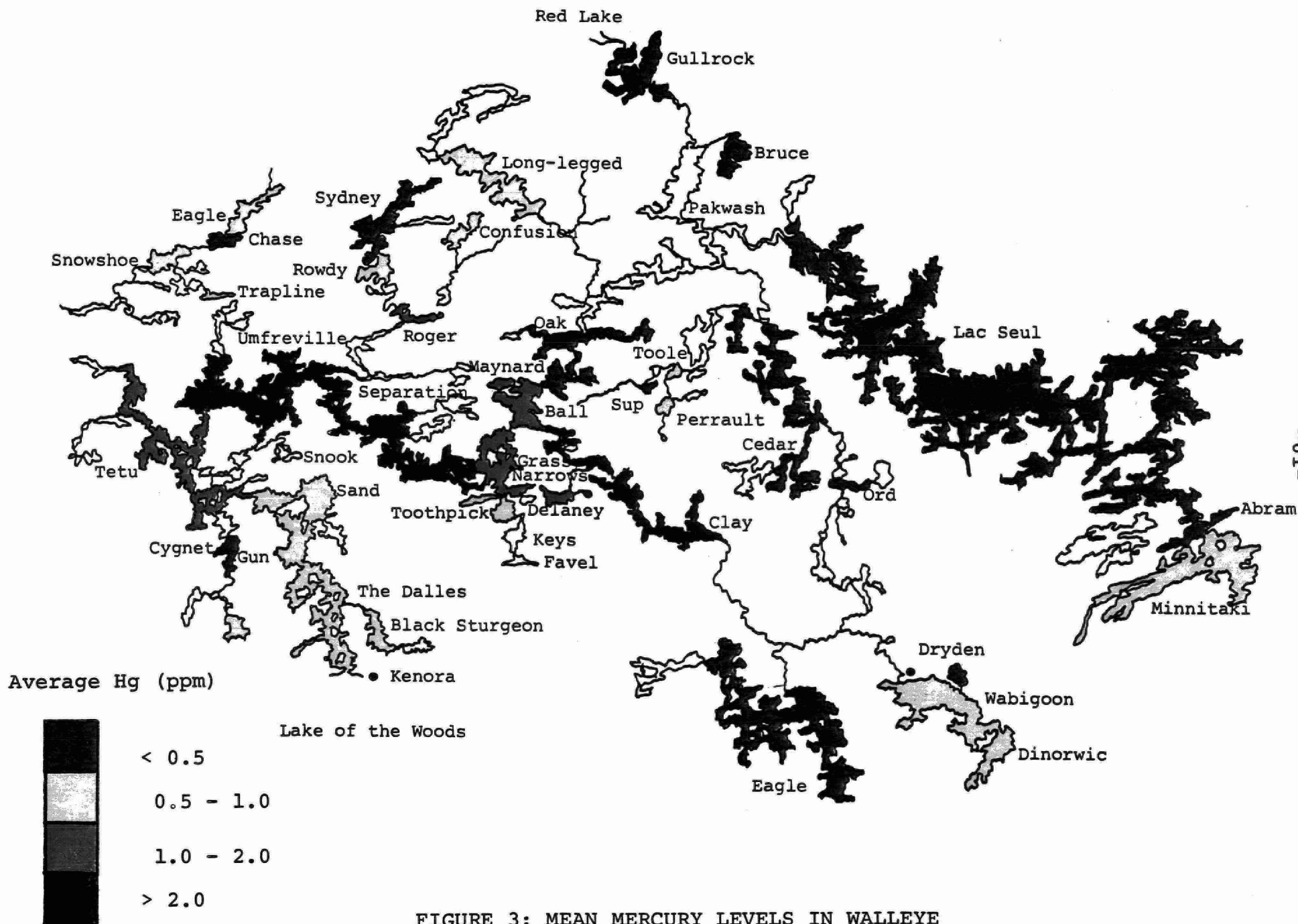


FIGURE 3: MEAN MERCURY LEVELS IN WALLEYE

FIGURE 4: NORMALIZED MERCURY CONCENTRATION IN PIKE (25")

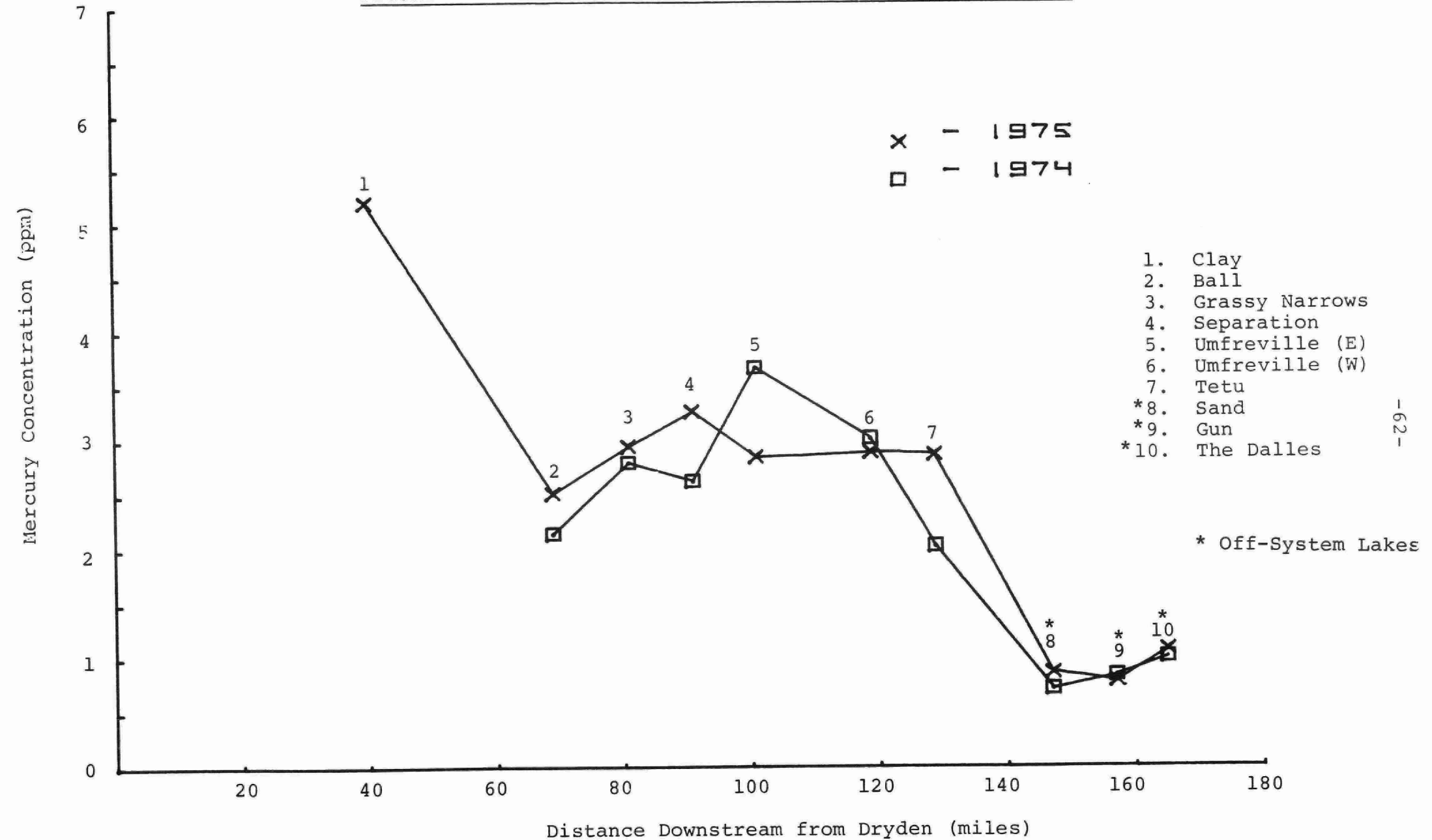


FIGURE 5: NORMALIZED MERCURY CONCENTRATION IN WALLEYE (20")

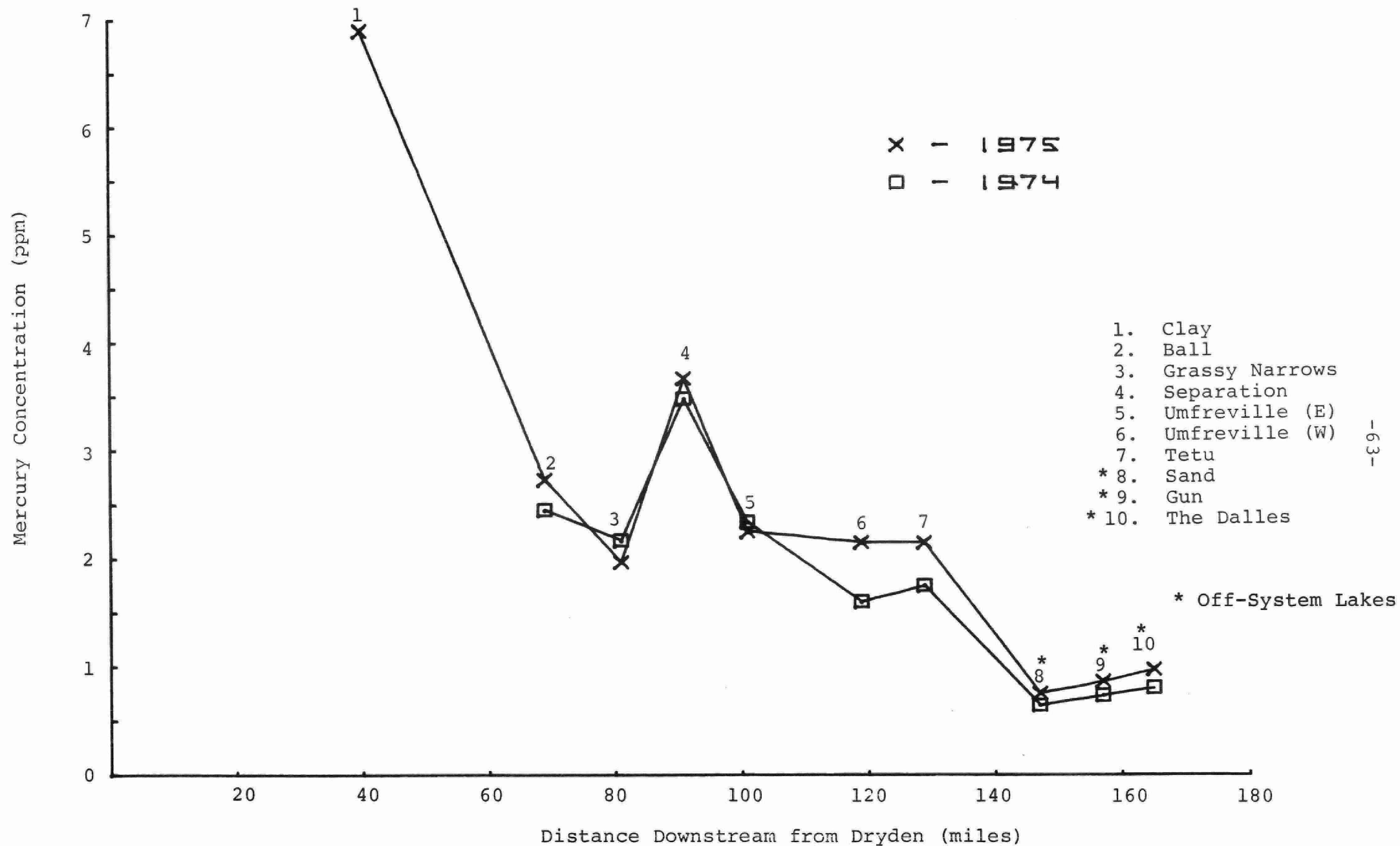


TABLE 22

MERCURY IN FISH FROM ON-SYSTEM LAKES (1975)

Lake	Normalized Mercury Concentration (ppm)		
	Pike (25")	Walleye (20")	Whitefish (20")
Clay	5.24	6.90	-
Ball	2.52	2.73	0.77
Grassy Narrows	2.95	1.97	0.55
Separation	3.27	3.67	0.68
Umfreville (E)	2.85	2.25	0.58
Umfreville (W)	2.89	2.15	0.57
Tetu	2.87	2.15	0.60

TABLE 23

MERCURY IN FISH FROM OFF-SYSTEM LAKES (1975)

Lake	Normalized Mercury Concentration (ppm)		
	Pike(25")	Walleye(20")	Whitefish(20")
Blueberry	1.10	0.79	-
Chase	0.67	0.81	-
The Dalles	1.07	0.97	-
Delaney	0.40	-	0.16
Eden	-	-	0.12
Eagle	1.21	1.09	-
Favel	-	-	0.18
Gooseneck	0.79	-	-
Gun	0.78	0.86	-
Keys	-	-	0.28
Marshaluk	-	-	0.04
Maynard	0.63	0.58	-
Meandering	0.98	1.10	-
Oak	0.66	0.62	0.11
Roughrock	0.78	0.92	-
Routine	0.87	1.07	-
Sand	0.86	0.75	0.07
Snook	0.72	-	-
Snowshoe	0.91	0.98	0.09
Sup	1.00	0.54	0.07
Toole	0.66	0.75	0.13
Toothpick	1.01	0.82	-
Trapline	1.18	1.32	-

The off-system lakes show no such trend; the normalized levels do not change greatly for any of the species examined in these lakes.

III: MINERALIZATION AND OTHER POSSIBLE SOURCES

There is no doubt that mercury occurs naturally in the bedrock throughout this entire portion of Northwestern Ontario. If this alone were responsible for the mercury levels in fish throughout the area, one would expect the mean mercury level for a given species to be somewhat similar from lake to lake. However, the highest mean mercury concentration in a species from any of the off-system lakes in the area is generally less than half of the lowest mean mercury level for the same species from an on-system lake, despite the fact that both on-system and off-system lakes occur in similar geological formations.

Elevated mercury levels in bedrock are usually associated with mineralization (31). Lakes in areas of known high mineralization might logically be expected to have fish populations with elevated mercury levels due to naturally occurring mercury. Red Lake is located in the vicinity of one of the most famous heavy metal deposits in Ontario. To date, only gold has been exploited, but cores from the area indicate large deposits of copper and zinc, and mercury levels in cores from the region are about twice as high as in cores from areas on non-mineralization (32). However, mercury levels in fish from Red Lake are not appreciably higher than those from other off-system lakes. One hundred walleye from Red Lake analyzed in 1971 by the FMSIB averaged 0.33 ppm (range 0.16 - 1.19) and the mean of 15 pike from Red Lake was 0.53 ppm (range 0.18 - 1.08). These means are well within the

range of values observed in off-system lakes. Similar conclusions can be made concerning Bruce Lake, the site of a large iron deposit. (See Table 20)

Mining activities, including the use of mercury in the amalgamation of gold and silver, and indigenous mercury associated with tailings and ore, have been suggested as the cause of mercury contamination of fish in the Wabigoon-English system. Again, if this were the case, lakes where extensive gold mining has been carried out for many years would be expected to be contaminated by mercury. However, as seen in the data for Red Lake, mercury concentrations in walleye and pike are not significantly higher than those found in the same species from lakes in the area where there is no mining activity (e.g. Long-legged Lake, Confusion Lake, etc.) and they are less than half the lowest values reported for these species in on-system lakes.

Fish in lakes near other mines in this region (Marmion Lake, Steep Rock Lake, Sturgeon Lake, Lac Seul, etc.) have mean mercury levels far below those found in lakes on the system. Consequently, the effects of mining do not appear to account for the mercury contamination of fish found in the lakes of the Wabigoon-English system.

Aerial fallout of mercury from point sources such as fossil fuel burning or smelting can also be discounted as a cause for elevated mercury levels because of the low incidence of such operations in this part of Ontario. Furthermore, the mercury fallout from such sources might produce an extensive zone of contamination but this is inconsistent with the observed mercury distribution pattern. The data indicates that the fish from the Wabigoon-

English on-system lakes contain significantly higher levels than fish in nearby off-system lakes.

IV: HISTORICAL MERCURY DATA

Mercury data from 1970 to 1975 is available on many lakes in the study area. Tables 24 and 25 show these historical mean mercury levels for the main species captured in some of the on-system and off-system lakes since 1970.

The most striking differences between the levels for on-system and off-system lakes is in the mean mercury values for a given species for each year. Species from on-system lakes are generally three to ten times higher than the same species from off-system lakes, regardless of year.

For off-system lakes there are no discernible trends within any species from year to year. For example, pike, walleye and smallmouth bass levels do not change significantly from 1970 to 1975 for any off-system lake. The data on Table 24 might be interpreted as indicating a trend towards decreasing mercury levels in fish from lakes on the Wabigoon-English system. However, these values are mean mercury concentrations and do not show the effect of changing fish weights. For some lakes sampled in the 1974 and 1975 surveys, enough data was obtained to allow a comparison of fish of equal size from both years (see Table 26).

These data show no indication of a significant decline in mercury levels from 1974 to 1975 for pike, walleye or whitefish. However, there has been a decline in mercury levels for some species in some on-system lakes since large-scale testing began in 1970.

TABLE 24

HISTORICAL MERCURY DATA, 1970-1975,
ON-SYSTEM LAKES

LAKE	SPECIES	MEAN MERCURY CONCENTRATION (ppm)					
		1970	1971	1972	1973	1974	1975
Ball	Pike	3.65	4.50	7.53		2.95	4.02
	Smallmouth Bass			2.29		2.39	1.45
	Walleye		2.94	2.96		2.45	1.58
	Whitefish			1.08		0.78	0.71
	White Sucker			3.43			1.33
Clay	Pike	9.24		3.03		4.22	5.18
	Walleye	12.0		7.67			5.98
	Whitefish	3.58		8.87		1.26	2.01
	White Sucker	3.83		2.24		1.28	
Grassy Narrows	Cisco					0.43	0.45
	Pike	4.26		3.30		2.28	2.81
	Sauger	3.12				2.11	1.94
	Walleye	2.16		2.08		1.90	1.63
	Whitefish					0.29	0.47
Indian	Pike		0.55	4.00			5.61
	Walleye	2.71	0.41	1.66			
Separation	Pike	5.00		4.05		2.96	2.84
	Walleye	2.99		2.93		2.77	2.99
	Whitefish					0.36	0.55
Tetu	Perch				1.33	0.11	0.92
	Pike	3.60		2.65	2.73	1.74	2.87
	Walleye	1.79			1.67	1.45	1.86
	Whitefish				0.45	0.55	0.63
Umfreville (E)	Pike	2.21		4.26		3.99	2.85
	Walleye	2.60		3.15		2.48	2.06
	Whitefish			0.65		0.50	0.56
Umfreville (W)	Pike	4.03				1.70	3.35
	Walleye	3.33				1.22	1.99
	Whitefish	1.03				0.60	0.47
Wabigoon R. between Ball L. and Clay L.	Pike	15.2		6.69			
	Walleye	6.80		5.42			
	Whitefish			2.18			
	White Sucker	4.19		3.63			

TABLE 25

HISTORICAL MERCURY DATA, 1970-1975,
OFF-SYSTEM LAKES

LAKE	SPECIES	MEAN MERCURY CONCENTRATION (ppm)					
		1970	1971	1972	1973	1974	1975
Blueberry	Pike				1.02		0.71
	Smallmouth Bass				0.65		0.60
	Walleye				0.80		0.58
The Dalles	Pike	0.88		1.12		1.12	1.15
	Sauger	0.27					0.74
	Smallmouth Bass			0.95		0.52	0.54
	Walleye	0.78		0.67		0.84	0.90
Delaney	Lake Trout				0.42		0.27
	Ling				0.25		0.44
	Pike				0.47		0.48
	Smallmouth Bass				0.24		0.27
	Whitefish				0.06		0.14
Gooseneck	Cisco				0.28		0.31
	Lake Trout				0.70		0.73
	Pike				1.24		0.81
	Smallmouth Bass				1.06		0.98
Gun	Cisco	0.54				0.31	0.12
	Pike	1.40				0.88	0.84
	Walleye	0.98				0.57	0.84
Keys	Lake Trout				0.41		0.41
	Ling				0.41		0.52
	Whitefish				0.17		0.24
Sand	Pike	1.04			1.38	0.69	1.08
	Walleye	1.39			1.12	0.59	0.77
	Whitefish	0.22			0.38		0.08
	White Sucker	0.40				0.10	0.32
Snook	Lake Trout				0.68		0.76
	Pike				0.83		0.70
Toothpick	Pike				1.02		0.83
	Walleye				0.86		0.73
Maynard	Pike	0.34		0.55			0.51
	Walleye	0.31		0.39			0.38
Oak	Pike	0.59	0.50		0.32		0.53
	Walleye	0.49	0.39		0.34		0.42
Confusion	Pike		0.84			0.32	
	Walleye			0.58		0.37	
Long Legged	Pike		0.59	0.64			
	Walleye		0.85	0.53			
Dinorwic	Walleye		0.54	0.57			

TABLE 26

1975 vs 1974

Lake (On-System)	Normalized Mercury Concentration (ppm)					
	Pike (25")		Walleye (20")		Whitefish (20")	
	1975	1974	1975	1974	1975	1974
Ball	2.52	2.15	2.73	2.45	0.77	0.49
Grassy Narrows	2.95	2.80	1.97	2.17	0.55	0.19
Separation	3.27	2.63	3.67	3.48	0.68	0.40
Tetu	2.87	2.03	2.15	1.75	0.60	-
Umfreville (E)	2.85	3.67	2.25	2.34	0.58	0.54
Umfreville (W)	2.89	3.02	2.15	1.60	0.57	0.61
Mean	2.89	2.72	2.49	2.30	0.62	0.45
Standard Deviation	0.24	0.60	0.63	0.67	0.08	0.16
Lake (Off-System)						
The Dalles	1.07	1.00	0.97	0.80	-	-
Gun	0.78	0.83	0.86	0.73	-	-
Sand	0.86	0.71	0.75	0.64	0.07	-
Mean	0.90	0.85	0.96	0.72	0.07	-
Standard Deviation	0.15	0.15	0.11	0.08	-	-

V: COMPARISON OF MERCURY LEVELS IN VARIOUS SPECIES

A review of mercury levels in fish from each of the lakes indicates that the species can be listed according to relative mercury concentrations. Certain species of fish are always higher than others in terms of mercury concentration, whether the fish are from lakes on the Wabigoon-English system or from off-system lakes. When the species are listed in descending order of mercury concentration for on-system and off-system lakes, a pattern emerges that remains generally constant from lake to lake. The usual pattern is as follows: pike > sauger > walleye ~ smallmouth bass > mooneye ~ cisco > white sucker ~ whitefish.

The pattern appears to be related to the feeding habits, metabolism, and habitat of each species. The predaceous fish such as walleye, pike and sauger always contain higher mercury levels than the less active, bottom-feeding species like whitefish and white sucker.

VI: RELATIONSHIP OF MERCURY INTAKE TO BODY BURDEN

There is a great difference between lakes on the Wabigoon-English system compared to off-system lakes in terms of the percentage of some species with mercury levels greater than the Federal guideline of 0.5 ppm.

For practically every lake on the Wabigoon-English system, at least 80% of the more predaceous species of fish have mercury concentrations greater than 0.5 ppm. In fact, for pike, perch, redhorse sucker, sauger, and walleye, the percent of speci-

mens with more than 0.5 ppm mercury is most often 100. Even whitefish and white sucker from lakes on the Wabigoon-English system are often high in mercury, with more than 50% of their individual specimens having more than 0.5 ppm mercury.

The off-system lakes only infrequently have species where more than 50% of the individual specimens have more than 0.5 ppm mercury. Species such as white sucker, whitefish, cisco, mooneye, perch, and rock bass are almost never greater than 0.5 ppm, and even piscivores such as walleye and pike are often less than 0.5 ppm. However, many off-system lakes cannot be considered as sources of fish for a "safe" consumption of protein, due to levels of mercury in some species in excess of 0.5 ppm.

The amount of mercury that can be safely consumed varies from one individual to another, depending on factors such as body weight and sensitivity. However, the World Health Organization (33) has determined that a body burden of 20 mg of mercury as methyl mercury could produce symptoms of mercury poisoning in some individuals. Virtually all mercury ingested by a person consuming mercury contaminated fish is in the form of methyl mercury (21). Almost all of it is absorbed into the blood stream, and the excretion rate is slow (about 1% of the body burden per day). An individual ingesting methyl mercury in fish every day will accumulate 99% of the theoretical total body burden, in about one year. At this point the body burden is about 100 times greater than the average amount of methyl mercury ingested each day (7).

It is believed that a portion of the population residing in north-western Ontario consume fish on a year-round basis. For calcu-

lation purposes, assume that an individual would consume an average of about one-half pound of fish daily. If this fish contained 1.00 ppm mercury this individual would ingest $230 \text{ gm} \times 1 \text{ ug/gm}$ or 230 ug mercury daily. After one year the body burden would be 23 mg mercury. Such a body burden is higher than the level which has been associated with the onset of some mercury poisoning symptoms in sensitive individuals (20 mg).

If the fish contained 0.5 ppm mercury, this individual would ingest $230 \text{ gm} \times 0.50 \text{ ug/gm}$ or 115 ug mercury and would have a body burden of 11.5 mg mercury after one year. Should the fish eating pattern indicate that greater quantities of fish are regularly consumed, the affected individual would be at greater risk.

VII: "SAFE" FISH LENGTHS

As previously mentioned, the mercury concentration in fish increases with the fish length. In order to provide some guidance concerning the size of fish which can be retained for consumption, the results of the regression analyses can be used to derive a "safe length" indicator. This length is obtained by calculating the 95% confidence interval about the regression of fish length on mercury concentration at the 0.5 ppm level, and results in a length at which 95% of the fish are at or below 0.5 ppm mercury.

The derivation of the "safe length" indicator is dependent on the nature of the relationship between fish length and mercury concentration. This tends to vary considerably between species, and from lake to lake. In relatively uncontaminated lakes, the relationship is often poorly defined (low correlation coefficient),

and a large change in fish length often results in little change in mercury concentration (low slope). This results in a regression with very wide confidence limits, and would yield a low "safe length". In contaminated lakes the correlation between length and mercury content is often better defined, and a variation in fish length will result in a large change in mercury concentration. The 95% confidence limits about such a regression are smaller than in the case of an uncontaminated lake, but the degree of contamination is such that the "safe length" is low. Thus, the "safe length" for fish from contaminated lakes is low, as one would expect, but the "safe length" for fish from relatively uncontaminated lakes is also low, due to the nature of the mercury-length relationship. For example, pike from Separation Lake are highly contaminated, having a mean mercury concentration of 2.84 ppm, while pike from Delaney Lake are about one-fifth as high, at an average of 0.48 ppm mercury. However, the "safe length" for pike in Separation Lake is 11.6 inches while it is 26.9 inches in Delaney.

Thus, while the "safe length" is not a sensitive indicator, it does provide a useful estimate of the size of fish that are fit for human consumption. The species most often sought by anglers are usually walleye and pike. Occasionally, other species such as whitefish are also captured and eaten. The "safe lengths" for walleye and pike are under 18 inches for all of the on-system lakes. Table 27 lists the "safe lengths" for the major species from the on-system and off-system lakes.

TABLE 27

LENGTHS AT WHICH 95% OF THE FISH ARE < 0.5 ppm MERCURY

Lake	Species	Mean Mercury (ppm)	"Safe Length" (inches)
Ball	Mooneye	0.80	9.9
	Pike	4.02	12.7
	Walleye	1.58	11.1
	Whitefish	0.71	15.9
	White Sucker	1.33	13.8
Blueberry	Perch	0.12	9.0
	Pike	0.71	16.1
	Walleye	0.58	12.1
	White Sucker	0.17	16.3
The Dalles	Mooneye	0.31	12.6
	Pike	1.15	16.4
	Sauger	0.74	7.7
	Walleye	0.90	12.5
	White Sucker	0.33	14.5
Delaney	Lake Trout	0.27	21.2
	Ling	0.44	18.7
	Pike	0.48	26.9
	Rock Bass	0.23	6.7
	Smallmouth Bass	0.27	14.0
	White Sucker	0.09	21.3
Gooseneck	Cisco	0.31	6.6
	Lake Trout	0.73	16.3
	Pike	0.73	16.4
	Smallmouth Bass	0.98	16.4
	White Sucker	0.18	14.7
Grassy Narrows	Cisco	0.45	12.3
	Mooneye	0.84	9.0
	Pike	2.81	12.5
	Sauger	1.94	7.4
	Walleye	1.63	8.6
	Whitefish	0.47	14.3
	White Sucker	0.76	13.4
Gun	Cisco	0.12	18.2
	Perch	0.18	8.9
	Pike	0.84	18.5
	Walleye	0.84	13.7
	White Sucker	0.23	15.1

Lake	Species	Mean Mercury (ppm)	"Safe Length" (inches)
Keys	Lake Trout	0.41	12.9
	Ling	0.52	12.0
	Whitefish	0.24	16.2
	White Sucker	0.23	27.7
Sand	Cisco	0.22	12.2
	Perch	0.19	8.3
	Pike	1.08	15.7
	Walleye	0.77	12.7
	White Sucker	0.32	14.8
Separation	Mooneye	1.21	10.0
	Pike	2.84	11.6
	Walleye	2.99	9.5
	Whitefish	0.55	13.4
	White Sucker	1.05	13.3
Snook	Cisco	0.27	7.6
	Lake Trout	0.76	14.5
	Pike	0.70	17.2
	White Sucker	0.24	17.3
Tetu	Pike	2.87	13.1
	Walleye	1.86	8.8
Toothpick	Cisco	0.13	16.5
	Pike	0.83	17.3
	Walleye	0.73	14.6
	White Sucker	0.25	16.0
Umfreville (E)	Walleye	2.06	13.1
Umfreville (W)	Ling	1.51	10.8
	Pike	3.35	17.9
	Walleye	1.99	12.8
	Whitefish	0.47	15.2
	White Sucker	0.99	16.4

CONCLUSIONS

Based on the mercury analysis of over 11,000 fish representing 19 species from 47 lakes, from 1970 to 1975, the following conclusions can be drawn:

- 1) Fish from lakes on the Wabigoon-English system are much higher in mercury concentration than fish from lakes off this system. This relationship holds true for every species encountered from both groups of lakes in the study.

The range of mean mercury concentrations for three key species from lakes on the Wabigoon-English River system (1975 data) was as follows: pike, 2.31 ppm to 5.18 ppm; walleye, 1.58 ppm to 5.98 ppm; and whitefish, 0.47 ppm to 2.01 ppm. The level of mercury was several times lower for fish from off-system lakes, when comparing the same species and sizes of fish. The range of mean mercury concentrations in fish from off-system lakes were: pike, 0.47 ppm to 1.39 ppm; walleye, 0.38 ppm to 1.08 ppm; and whitefish, 0.04 ppm to 0.24 ppm.

- 2) Factors such as mineralization, mining activities, and aerial fallout cannot account for the elevated mercury levels found in fish from the Wabigoon-English system of lakes. The major source of mercury pollution in the area is the chlor-alkali plant/pulp and paper mill complex in Dryden, Ontario.
- 3) Mercury levels in fish of similar size from the Wabigoon-English system have not declined from 1974 to 1975. There has been a decline in fish mercury levels for some species in some lakes since large-scale testing began in 1970. No

significant changes in mean mercury levels from 1970 to 1975 were observed in fish from off-system lakes for which data was available.

- 4) Mercury levels in fish from both off-system and on-system lakes were generally in the descending order: pike > sauger > walleye ~ smallmouth bass > mooneye ~ cisco > white sucker ~ whitefish.
- 5) Most species of fish from lakes on the Wabigoon-English system have mercury levels far in excess of the 0.5 ppm guideline set by the Food and Drug Directorate. There was practically no species from any lake on the system that could be considered fit for human consumption. These lakes include Ball, Clay, Grassy Narrows, Indian, Separation, Tetu, Tide, and Umfreville East and West. With the exceptions of the Winnipeg River, and those lakes directly connected to the Wabigoon-English system, most fish species from most lakes off the system could be considered safe for limited consumption but not on a daily basis.

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APPENDIX I

SPECIES OF FISH ANALYZED FOR MERCURY

<u>Common Names</u>	<u>Proper Names</u>
Bullhead (Brown Bullhead)	<i>Ictalurus nebulosis</i>
Carp	<i>Cyprinus carpio</i>
Catfish (Channel Catfish)	<i>Ictalurus punctatus</i>
Cisco (Lake Herring)	<i>Coregonus artedii</i>
Crappie (Black Crappie)	<i>Pomoxis nigromaculatus</i>
Lake Trout	<i>Salvelinus namaycush</i>
Ling (Burbot, Maria)	<i>Lota lota</i>
Mooneye	<i>Hiodon tergisus</i>
Muskie (Muskellunge)	<i>Esox masquinongy</i>
Perch (Yellow Perch)	<i>Perca flavescens</i>
Pike (Northern Pike, Jackfish)	<i>Esox lucius</i>
Redhorse Sucker (Northern Redhorse)	<i>Moxostoma macrolepidotum</i>
Rock Bass	<i>Ambloplites rupestris</i>
Sauger	<i>Stizostideon canadense</i>
Smallmouth Bass	<i>Micropterus dolomieu</i>
Sturgeon (Lake Sturgeon)	<i>Acipenser fulvescens</i>
Walleye (Pickerel, Yellow Walleye)	<i>Stizostideon vitreum</i>
Whitefish (Lake Whitefish)	<i>Coregonus clupeaformis</i>
White Sucker (Sucker, Mullet)	<i>Catostomus commersoni</i>

APPENDIX II

INDEX OF LAKES

Lake	Survey Year(s)	Table(s)	Page(s)
Ball	1975,74,72,71,70	3, 3-A	14, 15
Blueberry	1975,73	4, 4-A	16, 17
Bruce	1974	20	51
Buck	1975	19	46
Chase	1975	19	46
Clay	1975,74,72,70	18	44
Colonna	1973	20	51
Confusion	1974,72,71	20	51
Cygnets	1973	20	51
Delaney	1975,73	6, 6-A	20, 21
Dinorwic	1972,71	20	52
Eagle	1975,71	19	46
Eden	1975	10	46
Favel	1975	19	47
Gooseneck	1975,73	7, 7-A	22, 23
Grassy Narrows	1975,74,72,70	8, 8-A	24, 25
Gun	1975,74,70	9, 9-A	26, 27
Indian	1975,72,71,70	20	52
Keys	1975,73	10, 10-A	28, 29
Long-legged	1972,71,70	20	52, 53
Lount	1972	20	53
Marshalluk	1975	19	47
Maynard	1975,72,70	19	47
Meandering	1975	19	48
Oak	1975,73,71,70	10	48
Pistol	1975	20	53
Portal	1973	20	53
Roger	1972,70	20	53
Roughrock	1975	19	49
Routine	1975	19	49
Rowan	1972	20	54
Rowdy	1971,70	20	54
Sand	1975,74,73,70	11, 11-A	30, 31
Separation	1975,74,72,70	12, 12-A	32, 33
Scotty	1972,70	20	54
Snook	1975,73	13, 13-A	34, 35
Snowshoe	1975,72	19	49
Sup	1975	19	50
Sydney	1972,71,70	20	54, 55
Tetu	1975,74,73,72,70	14, 14-A	36, 37
The Dalles	1975,74,72,70	5, 5-A	18, 19
Tide	1975,70	20	55
Toole	1975	19	50
Toothpick	1975,73	15, 15-A	38, 39
Trapline	1975	19	50
Umfreville (E)	1975,74,72,70	16, 16-A	40, 41
Umfreville (W)	1975,74,72,70	17, 17-A	42, 43
Wabigoon	1971,70	20	55, 56



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